GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
**RAJYA SABHA**
**UNSTARRED QUESTION NO. 2125**
ANSWERED ON 07/08/2025

## NATURAL CALAMITIES IN THE COASTAL AREAS

**2125. SHRI G.C. CHANDRASHEKHAR:**

Will the Minister of **EARTH SCIENCES** be pleased to state:

(a) the details of advanced technologies and instruments, including AI/ML-based systems, deployed for predicting natural calamities in the coastal areas;
(b) the success rate of these systems in forecasting cyclones, storm surges and tsunamis in recent years;
(c) the steps taken to strengthen early warning dissemination and local-level preparedness in coastal States; and
(d) whether Government has assessed the impact of climate change on the frequency and intensity of such events and if so, the details thereof?

**ANSWER**
THE MINISTER OF STATE (INDEPENDENT CHARGE) FOR
MINISTRY OF SCIENCE AND TECHNOLOGY
AND EARTH SCIENCES
(DR. JITENDRA SINGH)

(a) Various organizations under the Ministry of Earth Sciences (MoES) use the latest advanced technologies and instruments for the early warning of natural calamities across the country, including the coastal areas.

The India Meteorological Department (IMD) uses the latest tools and technologies to predict severe weather events such as heat and cold waves, cyclones, heavy rainfall, etc. IMD uses advanced dynamical numerical weather prediction models with higher spatial and temporal resolutions, multi-model ensemble techniques, artificial intelligence and machine learning (AI/ML), and data science methodologies. Further, it uses a state-of-the-art remote sensing network consisting of satellites and radars for the real-time monitoring of weather. AI and machine learning are being used to improve weather, climate, and ocean forecasting skills across the country, including coastal areas.

The Indian National Centre for Ocean Information Services (INCOIS) is leveraging state-of-the-art instruments, advanced ocean-atmosphere modeling systems, and robust decision-support tools to enhance ocean observation and forecasting capabilities. It provides multi-hazard early warning services, including alerts for tsunamis, storm surges, high waves, swell surges, strong ocean currents, etc., during extreme oceanic events.

(b) The lead period and skill of the forecasts and warnings of extreme weather events (tropical cyclones, heavy rainfall events, thunderstorms, heat waves, cold waves, etc.) have improved significantly in the recent 10 years. For example, the forecast accuracy in 2023-2024 was 40% better compared to that in 2014.

INCOIS has been providing highly reliable multi-hazard oceanogenic advisories. These include timely and accurate warnings for tsunamis, storm surges, high waves, swell surges, and strong ocean currents associated with extreme weather and seismic events. Importantly, INCOIS has never issued a false tsunami warning, highlighting the precision, reliability, and operational integrity of its early warning systems. The Centre's multi-hazard advisory services have played a critical role in safeguarding coastal communities, supporting timely preparedness and evacuation measures, and significantly contributing to disaster risk reduction efforts across India.

(c) IMD and INCOIS use the state-of-the-art dissemination system to share weather and ocean information and early warnings with disaster management authorities and the general public through various platforms/channels for necessary preparedness and to support mitigation measures across the country, including coastal States. It includes social media, Common Alert Protocol, Mobile Apps, WhatsApp, and APIs. As a result, the vulnerable population in rural and coastal areas gets evacuated on time to safe shelters, thereby reducing the human death toll to a bare minimum.

IMD utilizes a seamless forecasting system at seasonal to nowcast scale and implements well-defined Standard Operating Procedures (SOPs) for monitoring & forecasting weather hazards. IMD, in coordination with other centres in the MoES, has developed an end-to-end GIS-based Decision Support System (DSS), which has been working as the front end of the early warning systems for the timely detection and monitoring of all-weather hazards across the country, including coastal States. It is supported with specific severe weather modules to provide timely impact-based early warnings for extreme weather events like cyclones, heavy rainfall, etc., which devastate human lives, livelihoods, and infrastructure.

INCOIS disseminates ocean information and advisory services to stakeholders through multiple communication channels, including SMS, email, website, the SACHET platform, WhatsApp groups, Telegram channels, and mobile applications. This multi-platform approach ensures the timely and wide-reaching delivery of critical ocean advisories and early warnings to diverse user groups.

To enhance awareness and strengthen community preparedness, INCOIS regularly undertakes capacity-building initiatives, including workshops, training programs, and annual tsunami mock drills. INCOIS also coordinates the implementation of the UNESCO-IOC "Tsunami Ready Recognition Programme" in India. As a significant milestone, Odisha has successfully implemented the programme and achieved UNESCO recognition for 26 coastal villages as "Tsunami Ready" communities, marking a commendable step towards coastal resilience and disaster risk reduction.

(d) Yes. The Ministry of Earth Sciences (MoES) has published a Climate Change report titled "Assessment of Climate Change over the Indian Region". The report has assessed the impact of climate change across the country, including coastal areas, and provides a comprehensive overview of regional climate change. It covers all major aspects of regional climate change, including the climatic extremes across India. The report is available at https://link.springer.com/book/10.1007/978-981-15-4327-2.

Based on the available climate records, the report documents that the surface air temperature over India has risen by about 0.7°C during 1901–2018 which is accompanied by an increase in atmospheric moisture content. The sea surface temperatures in the tropical Indian Ocean increased by about 1°C during 1951–2015.This has led to increased monsoon variability, extremes, etc. Regions, e.g., Central India, northern Indian regions, and Western Himalayas, have experienced a rise in extreme precipitation events; north and northwest India and neighboring Central India have experienced moderate droughts and expansion in semiarid regions, while coastal regions are at increased risk of cyclone-related disasters. The complex interactions between the Earth system components amidst the warming environment and regional anthropogenic influences have therefore led to a rise in the frequency of localized heavy rainfall events, drought and flood occurrences, an increase in the intensity of tropical cyclones, etc., in the last few decades. Future projections of regional climate, performed under different climate change scenarios, to indicate robust changes in the mean, variability, and extremes of several key climatic parameters over the Indian subcontinent and adjoining areas (e.g., land temperature and precipitation, monsoons, Indian Ocean temperature and sea level, tropical cyclones, Himalayan cryosphere, etc.).

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